

A Search for Mountain Waves in MLS Stratospheric Limb Radiances from the Winter Northern Hemisphere: Data Analysis and Global Mountain Wave Modeling

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Summary

This paper described a thorough study of the UARS MLS limb-track stratospheric radiance measurements in the northern hemisphere, and modeled the MLS measurements of gravity wave (GW) activities with a three-dimensional (3D) GW visibility function that models the sensitivity of the MLS instrument to GWs of different orientations and wavelengths with respect to the satellite orbit. This GW visibility function allows us to use global GW models, such as the Mountain Wave Forecast Model (MWFM) that is used in this study, to generate anticipated wave fields, then “orbit” an MLS like instrument around the Earth to simulate an MLS “measurement” of these model-generated waves, i.e., to simulate how they appear in MLS limb radiances. The comparison between the original model output and the MLS-sampled product has allowed us to separate out background wind effects, to identify GW sources, and to explicitly link specific features of these measurements to orographically generated mountain waves (MWs) in the extratropical northern hemisphere.

This work shows that MLS can provide critical global measurements on MW-induced temperature variability in the high-latitude stratosphere that could impact polar stratospheric cloud (PSC) formation. Such data are critical for refining and constraining parameterizations of these processes for global chemical transport model of stratospheric ozone evolution. On going research with data from MLS and other satellite instrument combined with various numerical simulations will provide a clearer global picture of GW dynamics and lead to new information on dominant wave sources, which is a major need for improving GW drag parameterizations for global climate and numerical weather forecast models.

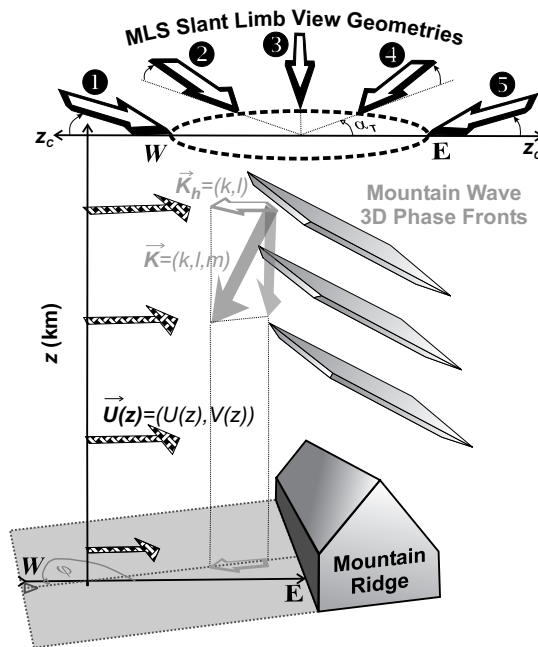


Figure 2: Schematic 3D depiction of mountain waves forced by eastward horizontal winds (U, V) over an idealized mountain ridge. Five potential MLS slant viewing geometries are envisaged as passing through its 3D structure while acquiring saturated radiances from this volume of atmosphere. Viewing geometry is most favorable for resolving this wave pattern because it views quasi-parallel to the waves phase fronts. Viewing geometry 5 is least favorable for the purpose.

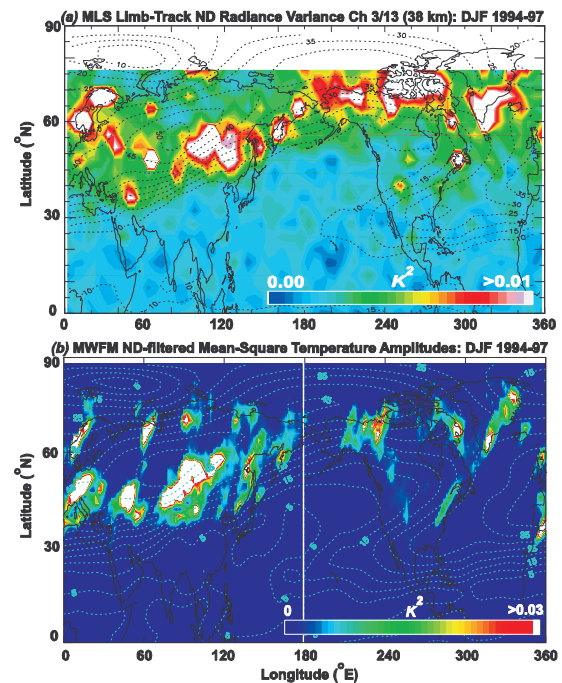


Figure 14: MLS north-looking descending limb-track radiance variances (a) compared with MWFM simulated mean-square peak mountain wave induced temperature amplitudes (b) after application of the MLS GW visibility filter. There is substantial agreement between the MWFM and MLS maps, and much improved over the unfiltered MWFM control run. This leads us to conclude that MLS indeed provides critical information on global MW activities propagating into the stratosphere.